APEC WORKSHOP

VIETNAM: FACILITATING DEVELOPMENT IN THE COAL AND POWER SECTORS

COAL MINING SAFETY

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1. INTRODUCTION

In early 1998, the Business Recorder carried the headline 'Coal mine collapses in Vietnam, three dead', and the following paragraph: 'HANOI (January 11): The ceiling of a coal mine in Northern Vietnam caved in on a group of miners, killing at least three people. It was unclear if more miners were still trapped inside the mine in Ninh Binh province, just south of the capital, Hanoi. The mine collapsed on Wednesday, but was only made public Saturday in Vietnam's state-controlled labour newspaper. Police and local mining officials are investigating the cause of the accident – a common occurrence in Vietnam's hazardous and poorly regulated mining industry'. *(www.brecorder.comstory/)*

In Australia, in New South Wales in July 1998, the final report of the Gretley (Underground Coal) Mine Inquiry found that the four deaths which occurred as a result of the accident which occurred some 18 months earlier, were preventable. The accident, a hole-through into abandoned workings, resulted in an inrush of water which swept away the crew driving a heading using a continuous miner, was ' the result of a string of oversights and professional failures'.

It is regrettable that incidents such as these contribute significantly to the public face of mining. Mining is a hazardous industry and no country can claim to be satisfied with its mining safety record as long as accidents continue to occur, and especially if such accidents result in fatalities.

Nevertheless, consciously focusing on working safely, by combining an approach in which the mine operator provides a safe working environment and the mineworker works safely within this environment, can lead to a substantial reduction in the accident level of this traditionally hazardous industry.

Coal mining exposes miners to hazards well in excess of those encountered by their industry colleagues in metalliferous mines. Exposure to the risks associated with methane gas and with fire and explosion together with those related to ground conditions and ground-water confirm the additionally hazardous nature of coal mining. The risks are lessened in open cut mining, particularly in large scale mechanised operations which, however, introduce other and different hazards which must be recognised and addressed in mine planning and in operations management.

This paper addresses issues of mine safety and mineworker health. Developed countries employing advanced mining technologies have long recognised the need for safety, and occupational health issues take precedence over all other operational matters. Many such countries have put in place legislative, organisational and management regimes, which assign responsibility for mine safety to the mine operator, clearly identifying where responsibility lies and providing a mechanism for ensuring that this does in fact, occur.

Reviews by the NSW Department of Mineral Resources following the Gretley Inquiry included reference to the philosophy employed in NSW (typical of other mining states in Australia) in 'managing' mining industry safety. The Department stated 'Current approaches to safety are based on a system of internal responsibility where both employer and employees are the first line in the provision of a safe and healthy work environment. Government's role is to oversee the system, offer advice where appropriate, and provide solid reinforcement where necessary. The internal responsibility system can and does work. It is at work today in mining and other hazardous industries across New South Wales, across Australia and around the world. The fact remains that coalmines in New South Wales are recognised by the International Labour Federation as among the safest in the world. Still, there is always room for improvement in educating workers, in planning for safety, communication and constant vigilance in what is a hazardous and ever changing environment'. *(Australian Journal of Mining, September 1998).*

2. THE VIETNAM COAL MINING SCENE

Vietnam has an abundance of mineral resources, most unmined. Lack of capital, and until recently, lack of interest on the part of international companies said to be due to the complexity and lack of clarity of the Vietnamese mining laws, and a lack of legal protection for mining rights, are said to be contributory factors. The 1996 new Vietnam Mining Law failed to offer any guarantees to an explorer who had to apply for an exploitation license once a discovery had been effected. Identified minerals include gold, rare earths, titanium, tin tungsten, chromite, nickel, copper, lead, zinc, bauxite, manganese and iron ore, in addition to a range of industrial minerals. Coal is the most abundant mineral with total reserves estimated by the US Department of Commerce *(http://strategic.is.gc.ca/SSG/dd76165e.html)*, in their July 1998 Market Assessment, at 2,863 million tonnes.

Figure 1. Vietnam

Statistical data on Vietnam's mineral deposits is limited and provides only varying and approximate information by western standards. Publicly available data is however, reasonably consistent and provides indicative information relative to the potential of the industry. Vietnam has substantial deposits of anthracite, hard coal and lignite. Total coal reserves (*the Mining Annual Review of 1994, p.115)* are estimated to be of the order of 20,000 Mt of which some 3,500 Mt are considered recoverable. Plans to raise production to 15 Mt/y, with exports forecast at 2.3 Mt were said to be in place in 1993.

Of the 2,863 Mt identified by the US Commerce Department, by far the most abundant is anthracite. The breakdown of reserves follows:

Anthracite	2,345 Million tonnes
Semi-Anthracite	78 Million tonnes
Coking Coal	38 Million tonnes
Thermal Coal	96 Million tonnes
Lignite	306 Million tonnes
TOTAL	2,863 Million tonnes.

Vietnam is not a major coal producer. In 1995 Cam Pha Coal Company, Hon Gai Coal Company Uong Bi Coal Company and Vietnam National Coal merged to form Vinacoal, an umbrella organisation set up by the Ministry of Energy although the companies continued to trade separately. Hon Gai's Han Tua and Ha Lam mines produced 1.4 million tonnes of coal, sold primarily for use in thermal power generation. Uong Bi Coal produced 1.3 million tonnes and Cam Pha 3.5 million tonnes. Vinacoal produced 550,000 tonnes for a combined production of 6.75 million tonnes in 1996. *(Asian Journal of Mining, September-October 1996).*

Reuters in 1999 reported that Vinacoal's 1999 plans were to include a substantial lift in coal production aiming to produce and sell 11.2 Mt locally and abroad, rising to 13 Mt in 2000. Lifting production involved the introduction of a long-term mining contract, seeking international participation in the industry. Late in the tender period, the announced tender ceiling price effectively eliminated foreign companies, resulting in a price which according to the unsuccessful tenderer could not result in a mining operation which adequately addressed 'technology, safety, training and environment issues', according to the Financial Express of March 31 1999. *(www.financialexpress.com.fe/daily/19990331/).*

The Mining Magazin e (*Vol 178, No 1)* describes the infrastructure supporting the coal industry as inadequate and outdated, but being improved. Access to Uong Bi, at the centre of the coal industry some 120 km from Hanoi takes three hours on crowded and substandard roads. Most mining except for a few coal operations is small scale, and employs outdated technology and equipment, with unorganised and unofficial mining occurring in the coal and other mining sectors. Coal is the most developed mineral sector, controlled through Vinacoal with production of 10 MT in 1997, of which 3.6 Mt was exported, mainly to China, Japan and other South East Asian countries. Vinacoal production targets were said to be 12 Mt by 2000 and 15 Mt by 2010. *(Mining Journal, January 1998)*

The limited information available carries the implication that there is appreciable scope for improvement in safety related issues within the coal mining industry.

3. COAL MINING SAFETY – ISSUES

Reference is made in general terms to issues which are significant in terms of coal mining safety. These are further described in the subsequent Section 4 which describes these and other issues in the context of a developing country industry appreciation. The Case Study also describes a process which has been employed to increase miner hazard awareness while concurrently reducing the impact of accidents and unsafe working practices.

3.1 Legislation, Regulation and Accountability

Mining operations in the western world are increasingly administered under legislation emphasising self-regulation and management responsibility, a major shift from the prescriptive practices of the past. Countries employing these 'owner onus' philosophies are included in those recording (relatively) low levels of mine related accidents, and particularly fatalities. Whether the decreasing trend is due to changes in the traditional role of Inspectorates or to an increased level of awareness has not been established. Notwithstanding, the change in emphasis could be applicable in developing economies where the Inspectorate structure is technically or numerically inadequate to sustain the enforcement role of the past.

Managing, controlling and improving mine safety is a function of the legislation, regulations and standards in place and which provide the basic to which operators must adhere. Today more is required. The basic rules prescribe the requirements for a safe work place and the need to work safely within a safe environment. The legislation cannot include the commitment of both management worker to perform all work in a safe manner and to eliminate or at least reduce the occurrence of accidents. This attitude is essential if the accident level is to be reduced to acceptable levels and to conform to industry best practice.

The legislative base provides a practical system where accountability for mine design, operations and safety is clearly defined. Roles of all industry participants, mine designers, mine management and supervisors, and particularly of mine workers are also clearly understood. The functions of Inspectors, once responsible only for enforcement of the various Mines Acts, is more broadly interpreted as part of the audit and educational process. Their responsibility for accident investigation remains, but with industry improvement, more emphasis can be placed on education and training. It is important that legislation keep pace with changing technology and that new and more efficient working methods are reflected both in mine operations and in acceptance by overseeing inspectors.

None of this detracts from the basic responsibility for a worker to work safely in a safe environment. The application of standards and of regulations relating to any aspect of mining operations is critical, providing guidelines which assist an operator and his workers achieve production targets, safely.

Standards address high-risk areas of mine and worker safety including use of explosives, ventilation, working in confined spaces and with, and operating mining machinery. Training programs encourage mining industry workers to understand the risks associated with their work and to approach these in a manner which reduces any risk to an acceptable level. An understanding of the role of others, imparted during training related to industry standards and practices can encourage workplace safety.

While individual mine operating conditions may vary and practices relate to the situation existing in any operation, the applications of lessons learnt in other and similar environments can lessen the prospect of accident occurrence. The transference of knowledge through guidelines and regulations is a sound approach to risk reduction in mine operations. Those who cannot comply with reasonable guidelines for safe working, as promulgated in mining regulations have no place in the industry.

3.2 Mining Work Practices

The rate of change in mining work practices has been substantial in countries in which mining plays a significant part of their national economic well being. Technological advances leading to higher productivity and increased competition have forced industry wide changes which are not yet reflected in work practices in many developing countries.

In the larger economies, the emphasis has moved well away from the capacity of an individual to perform to how optimum production can be achieved using highly sophisticated and specially designed equipment. Labor intensive practices have given way to increased mechanisation and greater output is being achieved with a reduced workforce.

This trend is not viewed with favour in many developing countries. A number of countries maintain some of the older practices while phasing in new and more productive techniques. Some countries cannot afford the luxury of scaling back a workforce by substituting equipment, finding that the employment generated in an industry requiring significant worker input is more important than the benefits resulting from the introduction of modern technology. It is important therefore that mine work practices do change and the changes relate to the environment in which mining is performed. Notwithstanding, a number of the changed practices have relevance in traditional mining operations.

Trends towards the use of machinery to replace manual methods will see continued growth even in labour intensive mines. Along with the change comes reduced risk as some activities formerly performed manually become machine functions. Reduced worker exposure, providing machine related hazards are understood and managed, can result from even a low level of mechanised activity.

One aspect of work practice changes which is transferable relates to the availability of more reliable and effective personnel protective equipment. In underground coal mines particularly, generally accepted as being at the upper end of the risk scale, the ability to provide improved self rescue equipment, gas detection, and underground communications all can contribute to a safer work environment. In many areas working hours have been reduced and underground transport relieves the burden of long walks to working faces, all reducing worker stress, and some of the factors leading to accidents resulting from lack of care or attention. Training of mine workers in all aspects of mining activity, particularly those relating to safe working has assumed high importance as a means of reducing both industrial and mine related accidents. Training in rescue techniques by mine workers, and in some cases the elimination of specific (area) mine rescue services in favour of mine based services promotes a greater awareness of the need to be self reliant in matters of safety.

The introduction of new and improved technology has brought with it improvements in mine economics, increases in production and productivity. It has also brought a capacity for a mine to reflect its enhanced operating environment in better organisation and planning and in improved and more freely available training and in mine and personal safety equipment.

Mines, and a mining industry, which aims to become a significant contributor to a country's economy through large scale production for domestic use or for export can no longer afford to neglect the health of its workforce. Comparative information from a range of mining operations (and countries) is available and those which fail to improve their safety performance will suffer economic loss in addition to workforce and production disruption, and to the social cost of a poorly managed and accident prone industry.

3.3 Mining Technology

Recent changes in technology have allowed those mining operations able to embrace change to achieve the flow-on effect which technology change has on worker (and mine) safety. Some changes are only applicable in large scale and capital intensive operations. Many technology advances have application in smaller and less well equipped mines and operators and enforcement authorities should be vigilant in ensuring benefits which can flow on, do so. Improved technology having implications for mine safety includes larger stopes, mechanised room and pillar and longwall mines and larger blasts all achieved with enhanced safety as a prime consideration.

Mining operations and practices are dictated by the technology employed. Advances in understanding many of the critical (and often hazardous) aspects of mining have an impact on worker safety and their incorporation, even in 'low level' operations can reduce the risk to mine workers. Current approaches to mine design include stress analysis, slope stability and the use of risk analysis as a tool for evaluation of a course of action. A better understanding of ground stresses and advances in roof support technology where roof bolting (installed by mechanised roof bolters) and hydraulic props are supplanting traditional timber sets and cantilevered sets has improved underground penetration and production rates - and resulted in safer working conditions.

Mechanised equipment with improved and upgraded performance characteristics such as drills, digging, transportation and loading equipment replacing the manual methods of the past have reduced the physical demands on mine workers resulting in less injuries and downtime. Underground coal mining has been revolutionised by longwall mining techniques which have led to the almost complete automation of mining and transportation of coal from underground sources. A better understanding of mine ventilation and improved ventilation systems have reduced worker stress and simultaneously reduced the proportions of the dust problem, also with reduced impact on worker health.

Significant technology changes have also occurred in open cut mining. Large-scale operations in which massive volumes of material are moved allow access to lower grade ore bodies permit mining at a scale far beyond the productive capacity of even the largest underground mine. Large open cut coalmines are becoming increasingly common-place in developed countries because of their emphasis on equipment rather than on manpower. Equipment in use for excavating includes draglines, excavators and Load/Haul/Dump (LHD) units or front-end loaders. Technological advances in open cut mining, particularly those associated with the size, mobility and travel speed of mining equipment and their control systems, give rise to a new set of safety issues requiring specific management plans. In western countries, the transition has been gradual but in developing countries, quantum leaps in technology introduce major safety management concerns.

Advances in technology associated with explosives use has resulted in blasting being a much less hazardous activity than formerly. Storage, handling and firing problems are much reduced when using modern formulated explosives and detonators in scientifically designed blast configurations.

Technological advances, most of which contribute to having less people exposed in hazardous situations are contributing substantially to mine safety. This is probably one major factor in the western mining world of a continuing downward trend in the reported accident occurrence rate. It does not however surpass the importance of worker awareness and working habits.

3.4 Mine Safety from the Gas Perspective

Flammable and toxic gases are by-products of normal underground coal mine operations. Methane is generally released as coal is mined, carbon monoxide is produced when coal oxidises and a range of flammable and toxic gases can be produced when coal spontaneously combusts or catches fire.

For a mine to operate in a safe manner the concentrations of the above types of gases needs to be known on an ongoing basis. Extensive research has been conducted in Australia on these issues and systems have been developed to improve the gas safety protocols currently in operation at underground coalmines. A range of research projects addressing these problems is in progress in industry testing stations in Australia.

The following areas of research are of particular relevance to coal mine safety:

- Spontaneous combustion
- Mine gas analysis
- Data interpretation
- Development of training courses

Spontaneous combustion.
Although spontaneous combustion has been studied for many years by all the major coal producing nations there are still many questions relating to this process which remain unanswered. Ongoing research focuses on the identification of gases which can be used as early indicators of spontaneous combustion.

A 16 tonne coal reactor has been constructed where large-scale coal samples can be allowed to spontaneously combust under controlled conditions. The work has indicated that there are no hard and fast rules which can be applied to all mines but that individual mines tend to behave in a unique manner. Gas ratios and trigger points for the appearance of gases of interest such as carbon monoxide or hydrogen tend to be mine specific and the use of internationally promoted parameters such as carbon monoxide make are of limited value unless reviewed against regional norms.

A data base of gas monitoring results and indicative ratios which tend to be specific to particular mines and which can be used by the mine management in the event of a spontaneous combustion incident is now being generated. Mine fires cannot be safely and efficiently fought if an understanding of the mine gases emanating from the coal mine is not acquired.

Mine Gas Analysis.
The only definitive way to analyse the complete composition of coalmine gas samples is by gas chromatography [GC]. GC enables the quantification of all of the relevant gases with the degree of sensitivity required to provide an early warning of potential problems within the mine. A range of gas analysis systems which enable a remote mine site to reliably carry out a gas chromatographic analysis on most types of mine gas samples has been developed and is commercially available.

CAMGAS or the new technology EZGAS gas analysis units are currently installed at all underground Queensland coalmines and an EZGAS unit is about to be installed in India. These GC based units enable the mine site to carry out a gas analysis and then using a computer modem link have the final result checked by an experienced gas chemist at a central laboratory. The system can also be used to reprogram the analysis device remotely in the event of a malfunction and effectively provides the services of a gas chemist at the mine site with limited associated expense.

CAMGAS units have been operational since the late 1980's and are now being replaced by the new EZGAS systems using high speed Gas Chromatographs which have reduced the analysis time from around 20 minutes to 2 minutes. This time saving is of critical importance in a mine emergency situation and adds a further factor of safety to the mines rescue process.

This type of gas analysis is only in use in Australia and is now being made available internationally.

Gas Data Interpretation

Modern analysis equipment such as gas chromatographs and continuous monitors are capable of generating enormous amounts of data. The interpretation of this data is a major problem for mine staff. A software package which processes the mine gas data into a series of ratios and pictograms which enable the mine management to gauge the extent of a mine fire or the potential for explosion has been developed. The SEGAS package is user friendly and is designed to be an intuitive product which can be used by personnel with limited computer capabilities.

The software utilises well known gas ratios developed across the mining world but also allows the user to develop his own mine specific parameters which are generally of more relevance to a particular coal mine. Various interfaces are available to allow the software to acquire the data from most types of gas monitoring equipment.

Training Courses.

Requirements of specific projects have resulted in the preparation and presentation of technical training to Indian coal mine inspectors including an extensive range of training courses in the areas of gas monitoring and interpretation. The practice of installing high tech equipment in developing countries is fraught with difficulties which can be mitigated by incorporating suitable training programs which can be included as part of the initial installation program.

4. CASE STUDY - REVIEW AND DEVELOPMENT OF SAFETY PROCEDURES AND MANAGEMENT SYSTEMS FOR THE INDIAN MINING INDUSTRY

Summary

The Indian mining industry is under considerable pressure to increase production levels to meet the current and future demands of the country's growing economy. In this changing environment, the industry is facing the challenge of increasing levels of mechanisation, the introduction and application of new technologies and the continuing liberalisation of the mining sector.

The Directorate General of Mines Safety (DGMS) is responsible for regulating and enforcing safety and occupational health in Indian mines. DGMS recognised a need to expose its officers to new technology, to modern developments in mining techniques and to the overall mine safety management systems employed in more advanced mining environments. The necessity to review existing safety standards, practices and legislative measures and develop new and appropriate safety standards are all issues that DGMS is currently attempting to address.

DGMS sought assistance from the Australian Government, subsequently provided through AusAID, the Australian Agency for International Development. This Case Study addresses the considerations, issues and strategies for the effective implementation of the Indian-Australian cooperative program that reviewed and developed new occupational health and safety standards and procedures and safety systems for the Indian mining industry. The staff of DGMS performed the development and introduction of new systems and procedures, with assistance and guidance from Australian industry specialists.

History of Indian Mining Legislation and Administration

The first Indian Mines Act was enacted in 1901. This Act was superseded by the Indian Mines Act 1923, which was again replaced by the present Mines Act, 1952. Major changes were incorporated in 1959 and 1983. The Mines Act, 1952 covers mines of all mineral types within India (with the exception of the State of Sikkim) including offshore mines within the limits of India's territorial waters. Currently, the Act applies to some 600 coalmines, more than 6000 metalliferous mines and 29 oil fields.

The Bureau of Mines Inspection was established in Calcutta in 1902 for the purpose of administering the Indian Mines Act. This organisation was renamed the Department of Mines in 1904 and the headquarters moved to Dhanbad. In 1960, the organisation's name was changed to the Office of the Chief Inspector of Mines. From 1967 it has been known as the Directorate General of Mines Safety (DGMS).

The safety, health and welfare of persons employed in the Indian mining industry is regulated by the Mines Act, 1952 and associated Rules and Regulations. The Act is administered by DGMS, under the Union Ministry of Labour. DGMS is a safety and training institution with zonal, regional and sub-regional offices distributed throughout India. It is staffed by qualified professionals in mining, electrical and mechanical engineering, occupational health, law, mine surveying, statistics and administrative staff. Included in the 940 staff are some 130 inspecting officers.

The broad functions of DGMS include:

- inspection of mines
- investigations into accidents and dangerous occurrences
- interaction for development of safety equipment, materials and safe work practices
- development of safety legislation and new safety standards
- granting of statutory permissions and exemptions under provisions of the Mines Act, 1952
- review of project reports and mining plans
- safety information dissemination
- conduct of examinations for granting statutory certificates
- safety promotional initiatives and programs including: organisation of conferences on safety in mines, national safety awards, safety weeks, safety campaigns, safety education, and awareness programs, workers' participation in safety management through workmen's inspectors, safety committee and tripartite review mechanism.

Mission of DGMS

The mission of DGMS is the reduction in risk of occupational diseases and casualty to persons employed in mines. By drafting appropriate legislation and setting standards, by overseeing their compliance as intensively as resources permit and through a variety of promotional initiatives and awareness programs, officers of DGMS exercise preventive and educational influence over the mining industry. DGMS is attempting to superimpose on it's traditional role of seeking compliance by legal sanctions and work prohibition, advisory and other safety promotional initiatives aiming to create an environment in which safety is given its proper priority. Within such an environment, DGMS is seeking to promote the concept of 'self-regulation' in addition to 'worker participation' in safety management".

Occupational Safety in Indian Mines

A summary of fatal and serious accidents in Indian coalmines from 1951 to 1991 is given in Table 1. Similar information, but on an annual basis for the years 1990 to 1999 is included in Table 2. The summary reveals a decreasing trend in fatal and serious accidents in Indian coalmines over the years. This reduction was most dramatic in the post-independence and pre-nationalisation period (1950 to the 1970's). However, since this period, the fatality rate per 1000 persons employed in coalmines has remained substantially unchanged. Serious injury rates show a marginal decline since the mid eighties.

Ten-yearly averages for fatalities and serious accidents for both coal and non-coal mines are given in Figure 1. Examination of these statistics indicates that the fatality rate in coalmines has remained relatively unchanged for the last fifteen years. In non-coal mines, after a steady decline for the first half of the century, the fatality rate has increased slightly in the 1990's.

These trends are cause for concern for the Indian mining industry and DGMS are now examining how this situation can be redressed. Table 3, which compares coal mine fatality rates in other countries, indicates further cause for concern. The data shows Indian fatality rates have remained 10-20 times higher than those in Australia and the USA.

Table 1: Accidents in Indian Coal Mines (1951-1991)

	Number of persons		Rate per 1000 persons		Rate per million tonnes	
Year	Fatalities	Serious injuries	Fatalities	Serious injuries	Fatalities	Serious injuries
1951	319	1931	0.91	5.69	9.3	57.2
1961	268	3569	0.65	8.77	4.81	64.7
1971	231	1542	0.60	4.03	3.05	20.4
1981	184	1213	0.36	2.36	1.45	9.5
1991	143	854	0.26	1.54	0.60	3.6

The incidence of accidents by reference to all indicators reflects a decreasing trend. Changes in the industry in recent years ie increasing production from a larger number of mines (and the phasing out of some older and uneconomic operations) are not reflected in the maintenance of accident rates recorded earlier. It is believed that recent programs and increased awareness is being reflected in the improved industry figures.

Table 2: Accidents in Indian Coal Mines (1990-1999) * Provisional

	Number	Number of persons		Rate per 1000 persons		Rate per million tonnes	
Year	Of Accidents	Fatalities	Serious injuries	Fatalities	Serious injuries	Fatalities	Serious injuries
1990	1044	166	983	0.30	1.79	0.78	4.62
1991	941	143	854	0.26	1.54	0.60	3.58
1992	975	183	894	0.33	1.62	0.73	3.57
1993	1010	176	903	0.32	1.65	0.68	3.49
1994	873	241	775	0.46	1.48	0.90	2.89
1995	894	219	813	0.43	1.58	0.77	2.86
1996	808	146	723	0.29	1.43	0.48	2.38
1997	820	165	725	0.33	1.44	0.52	2.28
1998 *	653	149	559	0.30	1.14	0.47	1.76
1999 *	508	143	420	0.29	0.86	0.45	1.32

Historically, the accident rate in the coal industry exceeds that of the metalliferous sector by a factor of two to three. Causes of coal mine accidents vary from year to year but major identified causes include (in approximate order of frequency), rope haulage, roof falls, dumpers and transportation machinery, falls (of persons and objects) and falls from walls. Surprisingly, relatively few accidents are attributed to gas, dust and fire, explosives, electricity and to other ground movements. The incidence is heavily biased towards worker related factors.

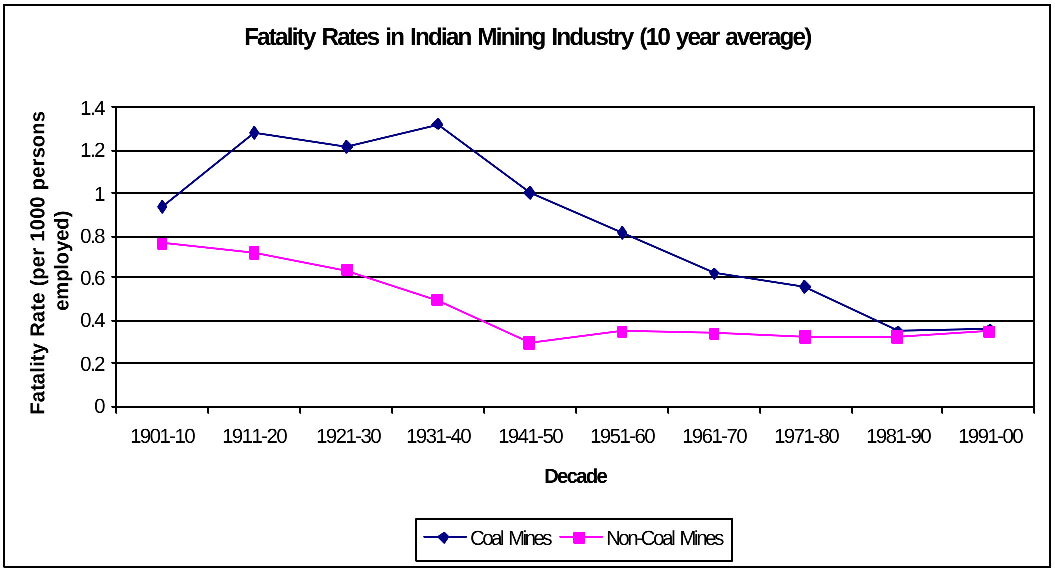

Figure 2: Ten Yearly Average for Fatality Rates in the Indian Mining Industry
(Ministry of Labour – Standard Note 01.01.95, Government of India)

Current Industry Situation

With the Indian mining industry under considerable pressure to increase production levels, demands on the industry include an increase in the level of mechanisation and in the rate of introduction of new technology. DGMS have identified a requirement to continuously upgrade and update their human resources and knowledge in line with developments in the global mining industry. DGMS have highlighted 'the urgent requirement to review existing safety standards, practices and legislative measures in different areas', as well as developing new and appropriate safety standards in certain areas *(DGMS, 1995 Mine Safety:Management of Technological Change – Project Report).*

It is important for DGMS to keep abreast of current international developments in relevant specialist fields to ensure that standards, guidelines and legislation are appropriate and represent the best current practice. To achieve these goals, DGMS believed it essential to expose the officers of Ministry of Labour and DGMS to the new technologies, modern developments in mining practices and the application of computers and overall mine safety management systems employed in advanced mining environments. *(DGMS, ibid).*

Table 3: Comparison of Coal Mines Fatality Rates in other Countries

	Fatality Rate per million tonnes of coal mined						
Year	India	Czech Rep. *	Japan	West Germany	U.K.	U.S.A.	Australia
1986	1.25	0.37	0.93	0.48	0.17	0.12	0.10
1987	0.93	0.27	0.61	0.39	0.11	0.08	0.02
1988	0.88	0.33	0.53	0.34	0.21	0.06	0.04
1989	0.86	0.35	0.68	0.41	0.24	0.07	0.03
1990	0.78	0.58	0.24	0.26	0.15	0.06	0.04
1991	0.60	0.33	0.12	0.32	0.14	0.06	0.09
1992	0.73	0.24	0.39	0.45	0.05	0.05	0.04
1993	0.70	0.15 *	0.28	0.22	N.A.	0.05	0.03
1994	0.90	0.12 *	0.14	0.29	N.A.	0.04	0.02
1995	0.77	0.26 *	0.32	0.26	N.A.	0.05	0.02
1996	0.48	0.15 *	0.00	0.25	N.A.	0.04	0.04
1997	0.52	0.23 *	0.47	0.19	N.A.	0.03	0.02
1998	0.47	0.13 *	N.A.	N.A.	N.A.	N.A.	N.A.

Australian Capabilities

DGMS believed international assistance, accessing relevant practices and experience to establish guidelines, standard testing procedures and standardised monitoring/design techniques was essential. The training being provided to the Mines Inspectorate is proving to be most useful in increasing the degree of acceptance of new mining technology.

Australia has significant capabilities both in mining and in training. Australia is recognised as one of the world's leading mining nations, with an well-organised, highly competitive and efficient industry. Australia has a large number of companies and organisations which provide a wide range of high quality services and technology to support both the Australian and international mining industries. Australia has world recognised services capabilities and technology in the following areas:

- mine planning
- mining software systems
- opencast mining techniques
- underground mining techniques
- maintenance management and training programs
- environmental management and rehabilitation
- mining industry training
- strata reinforcement technology
- hazardous mining technology

In September 1995, DGMS requested assistance from Australia, for the provision of a technical training program for DGMS officers which would permit exposure to Australian technology and mine safety practices. Joint Indian-Australian discussions during 1996 were able to define the project's objectives, the inputs required from India and Australia, the training methodologies and activities, and the expected outcomes. A draft outline of the proposed training program was formulated. Discussions were held with several Australian State mining inspectorates with regard to participation in the project. A detailed Project

Design Document was developed for AusAID consideration and following DGMS review, Government of Australia and Government of India approvals were obtained. In February 1997, AusAID undertook a competitive tendering process to select and appoint an Australian contractor to implement the proposed Australian assistance program. The Australian International Mine Safety Training Company (AIMSTC) was awarded the contract in June 1997 and implementation commenced the following month.

PROJECT DESCRIPTION

Project Development Goal and Purpose

The project goal is to improve occupational health and safety within the Indian mining industry. The project was to provide a technical training program for DGMS officers which will permit substantial exposure to Australian mine safety practices and technology and facilitate the development of enhanced occupational health and safety standards and procedures, codes of practices, legislative standards and mine safety information systems.

Achievement of the project purpose requires:

- DGMS senior officers being exposed to the current Australian industry safety practices, procedures and technology and senior Australian project team members gaining an appreciation of the Indian mining practices and industry.

- a structured training program to be established which develops and maintains a core group of DGMS trained officers, capable of adapting, developing and applying the relevant practices, procedures and technology within the Indian industry, and training other DGMS personnel.

- existing safety standards, practices and legislative measures in different areas to be reviewed and new and appropriate safety standards to be developed.

- a suitable project management and project monitoring framework for the effective planning, co-ordination and control of the project.

Industry Familiarisation

Implementing changes as a result of the training is more readily achieved if key senior DGMS officials have some exposure to Australian mining practices and the opportunity to interact with their counterparts in Australia. These senior DGMS officers have had an opportunity to become familiar with and gain an appreciation of those practices and techniques to which subsequent DGMS training teams will be exposed.

Senior Australian counterpart inspectors likewise required an appreciation of Indian mining industry practices to assist project implementation. These senior inspectors, familiar with the relevant Australian experience and practices, will be able to relate these to Indian industry practices. Finalisation of the training topics and the specific training program for each of the DGMS training teams was determined following the visits to India and Australia, respectively.

Training

The project is focusing on a number of training areas identified as requiring improvement:

- Longwall Face Support.
- Equipment Testing Standards and Approval Procedures.
- Underground Coal Mine Roadway Support and Pillar Extraction.
- New Technology in Hard Rock Mining.
- Open Cast Mining.

- Occupational Health and Safety.
- Mine Safety Management Systems.
- Environmental Management.

Details of the training areas are detailed in Table 4 (page 15).

Training programs were conducted in both Australia and India. All DGMS teams undertook 'pre-training' in India prior to leaving for Australia. Six teams each consisting of five DGMS officers visited Australia for a period of 6 to 8 weeks of training. Each DGMS Training Team at the completion of its training in Australia, prepared a report on the training program in Australia which included:

- the Training Team's assessment of the effectiveness of the training program
- specific Australian mining practices and technology having particular application to the Indian mining industry
- changes in these practices considered necessary in an Indian mining context.

Short-term follow-up visits by Australian project team members to assist DGMS in the ongoing development of the standard procedures; systems and practices were planned. The follow-up visits reinforced the Australian delivered training programs.

The successful and wider application of these safety practices and systems within DGMS and across the Indian mining industry required the establishment of an institutional training program within DGMS to deliver in-house training to all DGMS officers. The project training program is structured to qualify DGMS trainers to undertake on-going training of DGMS personnel, thereby maintaining the skills base and increasing the number of trained personnel within DGMS. To satisfy this requirement DGMS employed a Human Relations Officer with specific training responsibilities, which are being further, developed in the project 'extension'.

Review and Development of Safety Standards and Systems

On the basis of this review, the DGMS Project Team, together with assistance from Australian project personnel, developed new and updated safety standards, procedures and systems for the following general areas:

- support requirements for longwall faces and underground roadways
- codes of safe practice and legislative standards
- broad-based mine safety information systems
- occupational health and safety standards and parameters

DGMS did not believe that it would be possible to effect major industry changes or to fully implement recommendations arising from the project within the project period. However, it would be expected that standards would be developed, DGMS circulars would be issued to the industry and these would be, within a 2-3 year period after circulation, gradually brought into legislation.

A plan and schedule for developing and circulating any other safety standards, procedures and systems and the timetable for legislating of the standards, procedures and systems was developed. The ability of the DGMS project personnel to develop and effectively implement new safety standards and systems must be demonstrated within the project period if the project is to achieve long term enhanced occupational health and safety practices.

Table 4: Details of Training Areas for DGMS Officers

No.	Training Area	Topics of Main Focus
1	Longwall Face Support	strata control - design and monitoring of strata behaviour
		continuous, routine monitoring procedures
		longwall condition monitoring and equipment inspection procedures
		standardised guidelines for assessing and interpreting monitoring results
		standardised procedure for assessing or determining support load requirements support yield valve systems with particular regard to massive roof and cyclical loading conditions
2	Equipment Testing Standards and Approval Procedure	development of testing procedures for mine safety equipment
		development of testing standards
		rationalisation of standards
3	Underground Coal Mine Roadway Support and Pillar Extraction	standardisation procedure for determining roadway support design requirements
		standardisation of monitoring procedures
		pillar extraction procedures, techniques and guidelines
		requirement of roadway support consumables and procedures for assessing appropriateness support consumables
4	New Technology in Hard Rock Mining	mining methods for irregular deposits
		procedures for assessing stability of hanging walls in open stopes
		practice of mass blasting
5	Open Cast Mining	procedures for designing assessing and monitoring stability of slopes and dumps
		haul road design and maintenance procedures
		continuous monitoring and prediction techniques
		training procedures and testing standards for operators of mobile equipment
		safety procedures and rules for operation of mobile equipment
		communication and control systems for mobile equipment
6	Occupational Health and Safety	exposure to international guidelines for occupational health and safety
		safety legislation
		safe working practices
		standardised/rationalised legislature and occupational health and safety recording, monitoring and reporting measures
		spontaneous combustion and mines gases
		exposure to Australian mines rescue facilities and procedures
7	Mine Safety Management Systems	management information systems for developing comprehensive Mines Safety Information Systems
		risk assessment techniques
		understanding of the application of risk assessment procedures and techniques for use with Indian mining operations
8	Environmental Management	as related to mining activities

Management

The success of the project is to a large degree, dependent on the quality of the project management and the project support structure. It will be important for the project success to provide a suitable project management and project monitoring and reporting framework for the effective planning, coordination and control of the project. AusAID procedures, developed over many years provided this framework.

The project commenced in July 1997 and was scheduled to continue for three years with the following general structure:

Months 1-3	Initial senior delegations to India and Australia and finalisation of specific training programs for each of the DGMS teams.
Months 4-24	Training of DGMS teams in Australia and India
Months 7-24	DGMS in-house and external interaction with various research organisations, operators, manufacturers and external and internal counterparts
Months 13-36	Development of draft standard procedures, systems and codes of practice

Prior to the completion of the 36 month program, concerns which had been earlier expressed about the ability of individual mines inspectors, with limited authority, to introduce changed working practices in mines not under their direct control, re-emerged. Discussions relating to program sustainability, a key issue in aid programs involving technology transfer, led to the formulation of a number of 'extra' tasks, designed to ensure the program benefits continued after the conclusion of the aid component work.

CONSIDERATIONS AND STRATEGIES FOR IMPLEMENTATION

The following factors were considered in the project implementation:

- the size and diversity of the Indian mining industry
- the number of zonal/regional offices within the DGMS organisational structure
- the geographic separation of zones and regions
- the difficulty of communication between head office, zonal and regional offices.

The program had to be able to train a sufficient number of officers from all of the regional offices, an important consideration in determining the composition of the DGMS project teams. The involvement of all zonal Deputy Director Generals from the commencement of the project was seen as significant in ensuring that all zonal/regional offices were able to benefit from the program.

Sustainability Risks

Potential constraints to project sustainability have been well defined. It is clearly understood that the ability of the project to provide lasting improvements to the Indian mining industry on a long-term basis will be dependent on:

- The Ministry of Labour being able to effectively legislate the recommended standards, procedures and statutory changes arising from the project, in a suitable time frame;
- DGMS establishing the institutional structure, and training sufficient numbers of officers to implement and enforce the new standards, procedures and statutory changes.

A high level of commitment from DGMS has been identified as a key factor in ensuring the successful implementation of the project. This continuing commitment of DGMS to this project has been confirmed by:

- the strength of the DGSM project document accompanying the request for training assistance;
- the DGMS Project Management Team consists of relatively young individuals who will have ongoing long term involvement within the DGMS;
- the involvement of the Director General and the majority of the Deputy Director Generals in the senior delegations to Australia. The involvement of the Deputy Directory Generals is a key factor as they are responsible for all of the six mining zones in India.
- the request for and approval of a project extension which aimed to enhance the project's sustainability.

DGMS must acquire the ability to operate and manage the effects and benefits of the project on a long-term basis. The project has been designed such that training is provided to DGMS project officers during project implementation. However, it is critical that the DGMS institutional training structure established provides on-going training of DGMS officers.

Program reinforcement largely centred on the development and introduction into a series of mines, representative of industry practices, of structured safety management programs using the newly acquired skills and experience of the Inspectorate. The concept was to involve and get the commitment of the individual mines' management to the new approach to safe and healthy working and to use the mines where such programs were in place as demonstration mines for the industry at large. In the coal sector two underground mines employing different mining technology (longwall mining and conventional bord and pillar mining) were identified. One large-scale open cut coal mine was added to the program. A similar typical mine was identified in the non–coal sector.

This extended program is under way. Mines have been selected and the cooperation of mine management obtained. The Inspectorate will establish programs and mine management based on an adaptation of Australian models, with assistance and guidance from Australian specialists. Each mine will be subject to a continuing performance review and return visits by specialist advisers will review the progress achieved and advise on changes, if any are deemed necessary. This program aims to leave in place a series of 'model' mines which can serve the mining industry of India as in-country training centres and more importantly as an indicator of how health and safety can improve both working conditions and productivity at typical mines without the necessity for a large capital investment program.

Establishment of DGMS Institutional Training Program

The establishment and in-house training of DGMS technical and training groups has been identified as necessary for ensuring the continued application and support of the new safety practices, systems and technology. This will require qualified DGMS trainers capable of undertaking on-going training of DGMS personnel to maintain the organisation's skills base and increase the number of trained personnel. This need has been satisfied to some extent in the project 'extension'.

At the completion of the project, DGMS will possess trained personnel who can manage the on-going application of the new standards and procedures. DGMS project personnel would be trained to a level whereby they understand and appreciate the technical criteria governing the application of the standards and procedures under various conditions. DGMS will need to develop a training plan and register (or similar quality control system) that is integrated into the training structure to ensure that adequate training standards are maintained.

The project will assist DGMS to establish an effective institutional training structure that:

- provides on-going training of DGMS officers
- allows DGMS to be effective as a 'change agent' in the industry.

The involvement of the Australian mining inspectorates in this project is a component critical to its success. AIMSTC obtained the support from three Australian State mining inspectorates for involvement of their personnel in this project (Queensland, New South Wales and Victoria). The involvement of three state mining inspectorates provided DGMS delegations and training teams with a broad range of Australian mining inspectorate perspectives, extensive opportunities to interact with their counterpart inspectors and an increased understanding and appreciation of Australian practices and procedures, over a wide range of different operating environments.

Whether or not this project can provide improvements to the Indian mining industry on a long-term basis will be dependent on the effectiveness of its implementation. Enforcement of the recommended standards, procedures and statutory changes arising from the project and DGMS establishment of the institutional structure to provide sufficient numbers of trained officers to implement and enforce these is mandatory if its objectives are to be achieved. The indications are that there is a steady improvement in industry attitudes and performance and it is not unreasonable to attribute some, at least, of the improved performance to the program.

It is expected that new standards will be developed and circulated to the industry within the project period, however, these will not be mandated. It is anticipated that these standards would be gradually brought into legislation over a period of 2-3 years from circulation.

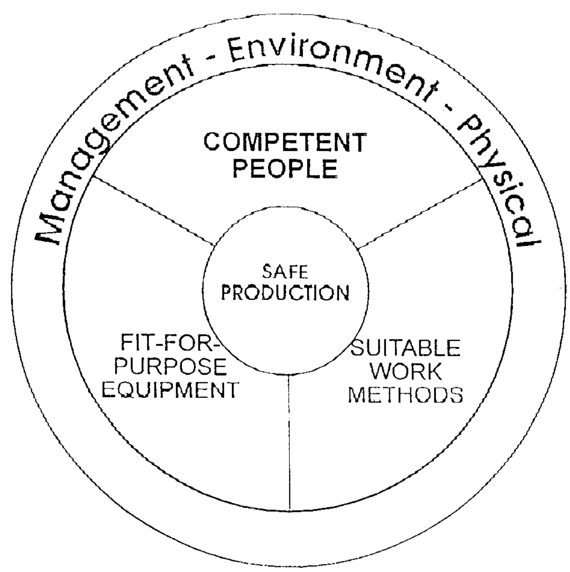

Figure 3: Conceptual model for mine safety management

The DGMS training program has the ability to change the current industry practices in the area of mining related occupational health and safety. However, it is not expected to change some of the entrenched social and labour practices in the Indian mining industry. Ultimately, large scale efficiency and profitability improvements in the Indian coal mining industry will require the Government to implement certain economic policy changes and liberalisation measures to remove many of the constraints that now impact on the coal sector. Similarly, changes will be driven by the increasing penetration of the mining sector by private sector interests with a focus on profitability, supported by continuing emphasis on aspects of mining concerned with social responsibilities. Nevertheless, this training program will provide DGMS with the necessary internal knowledge to formulate mining standards, practices and safety legislation that will improve substantially on those currently in use. Concurrently, the project will provide DGMS with exposure to new mining technology and practices and the framework to formulate appropriate standards and legislation to support their application in the Indian mining industry.

It is envisaged that this project will re-orient DGMS and the Indian mining industry from the current enforcement based prescriptive-type framework into an era of self-regulation for the safety and health of Indian mineworkers. A conceptual model for such a safety management framework is shown in Figure 3.

5. CONCLUSION

The paper sets out to demonstrate that it is possible in a fairly short time frame to improve the safety record of an industry which gives an impression of suspect performance and attitudes towards internationally accepted standards of worker health and safety. Mining, particularly coal mining is a hazardous industry, but if industry participants recognise their specific responsibilities and address these, the downside of mining accidents can be minimised.

Mine safety is an attitude of mind. It cannot be effectively legislated. It requires a safety conscious worker and a safe working environment. The first is a matter of education and training. Increasing degrees of skill are being required for the more technologically developed and equipped mines, and it is the mine operator's responsibility to adequately equip his workforce both physically and mentally. It is likewise the mine operator's responsibility to provide a safe working environment and standards; legislation and guideline provide some guidance on how this can be achieved. Notwithstanding, it is the responsibility of each individual mineworker to perform his duties in a safe manner, not only to ensure his own safety but also that of his workmates. Only by the application of safe working principles to all aspects of mining operations can some inroads be made into the devastating societal toll of mine accidents.

Mining inspectorates drawing on international experience, compensated for, but not compromised by local conditions can provide a basis for a mine operator to identify risks and to work within an acceptable risk profile. The extended role of mining inspectorates is to provide information, to assist with education and to assist a mine owner with establishing safety management plans, specific to each mining operation. Unfortunately, the role also extends to accident reporting, investigation and too frequently to prosecutions for infringements where an incident has become an accident and injury or death results.

Mines inspectors would willingly forgo this role in an ideal (mining) world where accidents become a thing of the past. This is an objective we should all work towards.

6. ACKNOWLEDGMENTS

This paper draws extensively on previous work by the AIMSTC/DGMS project team, in particular, a paper presented at the International Seminar on Prevention, Investigation and Settlement of Serious Coal Mine Accidents in Beijing in December 1997, by Robert Guy and Stewart Bell of AIMSTC and Rahul Guha of DGMS. AIMSTC colleagues have cooperated in the providing information for the 'issues' section of the paper.

The Australian Trade Commission (and the trade group Austmine) provided information relating to the Vietnam Coal industry and reference to a number of websites, assisted in gaining a limited appreciation of the status of the Vietnamese coal industry today. Its embryonic status and the absence of published statistical data on coal production and on safety aspects of the industry make references to these aspects of the industry in the paper, very general.

The Case Study describes a project now in its fourth year jointly funded by the Australian and Indian Governments. The contribution of the Australian aid agency (AusAID) in setting up and funding the program, and in permitting the objectives and accomplishments described in this paper is appreciated and gratefully acknowledged. All involved in the program are confident that lasting benefits will be realised.

While the contributions listed above are acknowledged with appreciation, the responsibility for information included in the paper remains solely with the author.

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